Balsam Fir

Forest Service
U. S. DEPARTMENT OF AGRICULTURE

BALSAM FIR

(*Abies balsamea*)

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Balsam fir is a small to medium-sized, short-lived northern tree. In this country it grows in the Northeastern States and in the Lake States. In Canada its growth range is much more extensive. Balsam fir occasionally occurs in pure stands but generally in mixture with other species, especially eastern spruce.[1] The tree is a prolific seeder and readily reforests cut-over areas, provided there is a continuous and ample supply of moisture. The soft, weak wood is light in weight and color, and ranks low in decay resistance. It has excellent pulping properties and is used principally for paper pulp, which goes into the manufacture of a wide range of papers.

The rapid expansion of the pulp and paper industry in this country has caused the increasing use of substitutes such as balsam fir in place of the more valuable spruce as the shortage of spruce has become more and more acute. There has been a prejudice against the use of balsam fir for pulp largely because of the high percentage of rot in balsam fir supplied to pulp mills. This prejudice has lessened as restrictions against decay in pulpwood have become general, and while balsam fir is not the equal of spruce for pulping purposes, it is nevertheless considered to be a high-grade pulpwood and in recent years has ranked fifth in quantity consumed among the 10 leading woods that furnish over 90 percent of our pulpwood requirements. Balsam fir lumber is used in comparatively small quantities for containers of various kinds and for building purposes. The needles of balsam fir with their spicy odor are frequently used for stuffing cushions, and the young trees are in demand as Christmas trees. The numerous and prominent blisters on the bark of balsam fir trees contain a resin known as Canada balsam.

Balsam fir trees are especially subject to attack by fungi which cause butt rot. Up to 40 years of age there is generally little evidence of attack, but after that the percentage of defective trees increases rapidly, and the butt logs of trees 70 years old are often unfit for pulpwood or lumber.

Nomenclature.—The name balsam fir is in common use. It is sometimes shortened to balsam. Other names are Canada balsam, blister pine, and firtree.

Distribution and growth.—In the United States balsam fir grows in New England, New York, Pennsylvania, and southward along the Appalachian Mountains to Tennessee, and also in the northern portions

[1] Eastern spruce includes red spruce, white spruce, and black spruce.

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of the Lake States (fig. 1). In Canada the growth range is much greater, extending from the Atlantic coast almost to the Pacific coast. For its best development balsam fir requires a constant supply of ground moisture, a cold climate, and a moderately deep sand loam soil. In parts of Maine, where such conditions are found, the average diameter and height of all types of trees at various ages were as follows:[2]

Age (years):	*Diameter (inches)*	*Height (feet)*
20	1.2	14
30	2.7	25
40	4.1	36
60	6.7	52
80	8.9	64
100	10.7	71

In the Lake States, where growth conditions are less satisfactory, largely on account of the comparatively limited rainfall, the average rate of growth is slower. For the first few years balsam fir will grow in dense shade, but as it grows older it requires more sunlight for maximum development, although it is able to survive periods of severe suppression and to resume satisfactory growth when freed from overtopping trees.[3] In light requirements the tree is more exacting than its frequent associates—red spruce and eastern hemlock—but less so than eastern white pine and tamarack. Balsam fir bears cones containing seed when about 20 years old. Plentiful seed years occur at intervals of from 2 to 4 years. Dominant trees produce the most seed, while suppressed trees sometimes do not produce any. The cones ripen and disintegrate on the tree during the fall of the year, and the seeds are scattered and germinate the following spring provided they fall in a favorable place, such as moist leaf litter, duff, moss, or rotten logs.

Balsam fir trees are very susceptible to damage by wood-rotting fungi that attack the heartwood. These include a brown cubical butt rot,[4] a yellow stringy butt rot,[5] and a red rot[6] that occurs in the upper part of the bole of overmature trees. The butt rots nearly always enter the tree through frost cracks or other wounds in the roots and rapidly extend to the trunk. Top rot also reaches the heartwood through cracks or through wounds caused by falling trees, porcupines, winds, etc. Studies made in the Lake States and in the Northeastern States indicate that up to 40 years of age few trees contain decay. After that the percentage of decayed trees increases rapidly, and at 70 years about 60 percent are infected with butt rot necessitating long butting, that is, cutting off and discarding the infected butts. At 130 years practically all have butt rot. The tree is easily uprooted and broken by wind because of its shallow root system and brittle wood. Trees weakened by decay are, of course, particularly susceptible to wind breakage. Balsam fir is also sensitive to fire as the bark is thin and tender and rich in resin. The spruce budworm and the fire bark louse are other enemies of the tree from which it has suffered severely from time to time.

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[2] See ZON, R. BALSAM FIR. U. S. Dept. Agr. Bul. 55, 68 pp., illus. 1914. These figures are of little significance as an indication of what may be expected under proper and practical forest management.

[3] Trees that have been severely suppressed are more liable to attack by trunk rot than trees that have had a uniformly thrifty growth.

[4] Caused by *Polyporus balsameas.*

[5] Caused by *Poria subacida.*

[6] Caused by *Stereum sanguinoleuntum.*

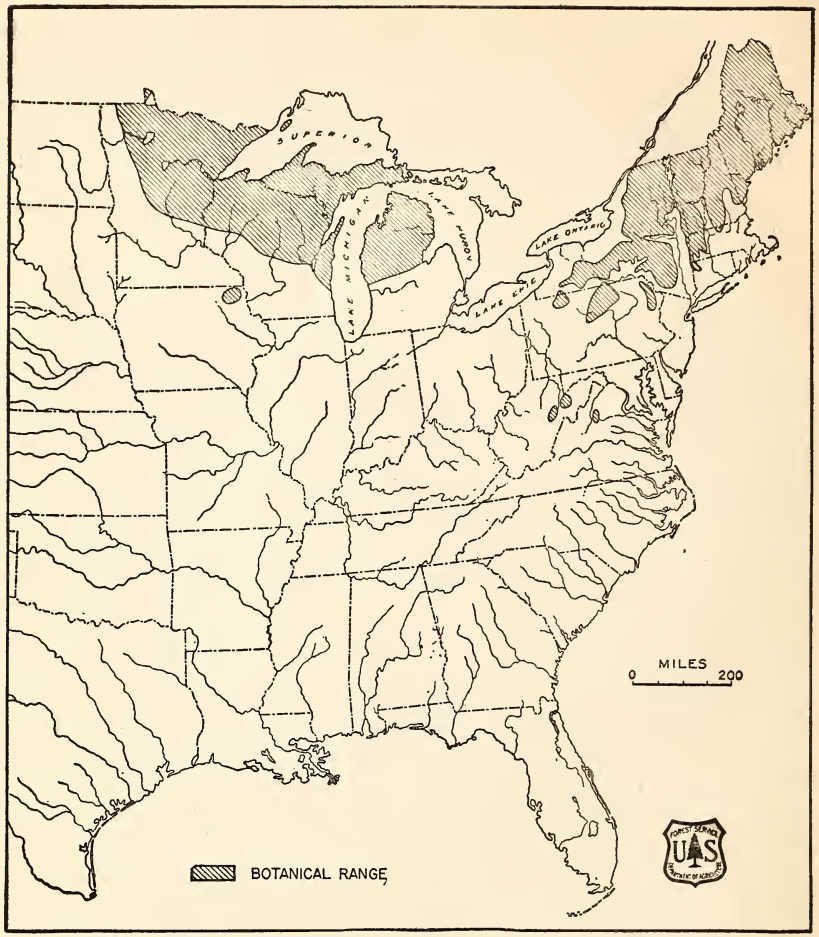

FIGURE 1.—Range of balsam fir (*Abies balsamea*) in the United States.

Since cull decay is not appreciable in balsam fir until the trees are about 50 years old and since the losses from decay and windfall become critical at about 70 years, the difference between these ages—20 years—is the maximum time between cuttings for the best utilization of the species. Partial cutting of mixed stands of balsam fir and spruce at intervals of not more than 20 years, removing balsam fir at 50 to 70 years of age and spruce on a selection basis, coupled with cultural treatment to maintain a thrifty growth of properly spaced crop trees, will not only reduce the loss from rot and windfall, but also will increase markedly the average diameter of balsam fir before cull and windfall become critical. Such a system of forest management will definitely increase and may well double the average yields per acre from spruce-fir forests.[7]

[7] Findings by the Northeastern Forest Experiment Station of the Forest Service, U. S. Department of Agriculture.

Supply.—The total stand of eastern spruce [8] and balsam fir of saw-timber size in the United States is placed at 24,086,000,000 board feet.[9] Of this total, probably one-quarter, or approximately 6,000,000,000 board feet, is balsam fir located in the Lake States and in the Northeastern States. A forest survey recently completed in the Lake States [10] showed the stand of balsam fir saw timber to be slightly over 1,000,000,000 board feet, leaving about 5,000,000,000 board feet as the estimated stand in the Northeastern States.[11] The amount of balsam fir saw timber and pulpwood in the Lake States was as follows:

	Saw timber (board feet)	*High grade pulpwood (cords)*
Minnesota	359, 310, 000	2, 551, 000
Wisconsin	133, 000, 000	956, 000
Michigan	606, 000, 000	3, 928, 000
Total	1, 089, 310, 000	7, 435, 000

The total stand of balsam fir timber in the Lake States includes about 271,000,000 board feet of timber in old-growth stands; about 409,000,000 board feet in second-growth stands; and about 409,000,000 board feet scattered through cordwood stands and elsewhere.

Production of lumber.—The earliest year in which the amount of lumber produced from balsam fir was reported separately from other species was in 1905. In that year the cut was 35,506,000 board feet (fig. 2). By 1909 production had risen to 108,702,000 board feet, after which it dropped and then rose to its maximum of 125,212,000 board feet in 1914. Since then the trend has been downward with an all-time low of 2,799,000 board feet in 1933—a year of depression in business. Production has risen irregularly since 1933. In 1942 it was approximately 9,000,000 board feet and in 1943, 7,337,000 board feet. The average annual production of balsam fir lumber for the 10-year period 1934–43 was 12,200,000 board feet. The average annual cut from the New England States during this period was about 9,000,000 board feet and from the Lake States about 2,700,000 board feet.

Maine has been the leading State in the production of balsam fir lumber since records have been available,[12] frequently producing one-half or more of the annual cut of that species. Up to 1929 Minnesota generally ranked second as a producer of balsam fir lumber and since then Vermont has generally occupied second place except for the few years when it was first.

Pulpwood.[13]—The consumption of balsam fir pulpwood amounted to 56,744 cords in 1905.[14] This was 1.8 percent of the consumption of all pulpwood in the United States. Five years later consumption had risen to 132,362 cords (fig. 3) and represented 3.2 percent of all pulpwood used. The consumption of balsam fir pulpwood continued to rise

[8] Includes red spruce, white spruce, and black spruce.

[9] U. S. CONGRESS, JOINT COMMITTEE ON FORESTRY. FOREST LANDS OF THE UNITED STATES. 77th Cong., 1st sess., S. Doc. 32, 44 pp. 1941.

[10] See CUNNINGHAM, R. N., and MOSER, H. C. FOREST AREAS AND TIMBER VOLUMES IN THE LAKE STATES. U. S. Forest Serv., Lake States Forest Expt. Sta. Rpt. 84 pp., illus. 1938.

[11] It is probable that a large proportion of the stand of balsam fir in the Northeastern States, possibly from one-third to one-half, is located in Maine.

[12] Except in the years 1929, 1931, and 1933 when Minnesota ranked first and in the years 1930, 1940, 1941, 1942, and 1943 when Vermont was first.

[13] The figures for the consumption of balsam fir pulpwood are undoubtedly smaller than they should be as an appreciable amount of the balsam fir that is cut in mixture with spruce is sold as spruce and reported as such.

[14] The earliest year in which pulpwood statistics for balsam fir are available.

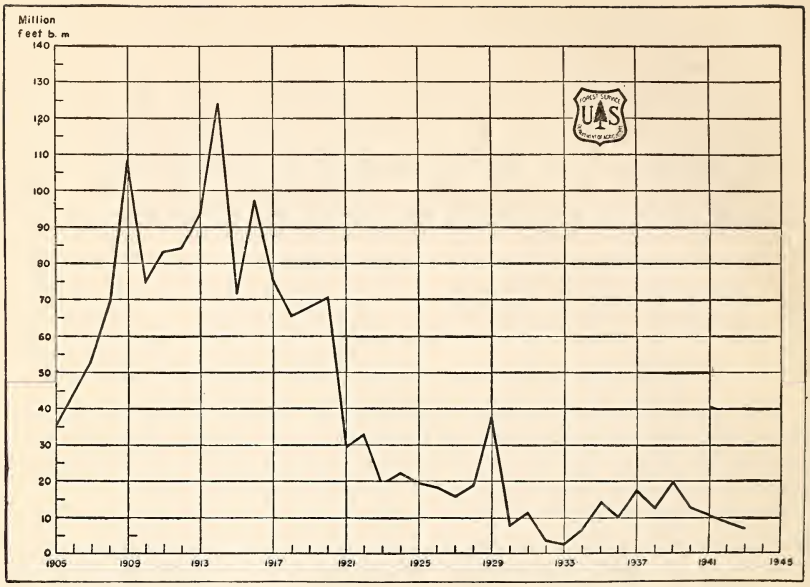

FIGURE 2.—Lumber production of balsam fir (*Abies balsamea*), 1905–43.

irregularly until 1917 when it was 382,036 cords, representing 7 percent of all pulpwood consumed. Since 1917 the annual consumption of balsam fir pulpwood has not dropped below 200,000 cords. In 1940 it reached its maximum of approximately 389,000 cords, representing 2.8 percent of all pulpwood used. The average annual consumption for the 10-year period 1931–40 was approximately 311,000 cords, equivalent to about 93,000,000 board feet.[15] This is over eight times as much as the average annual production of balsam fir lumber during the same period. Up to 1923 the greater part of the balsam fir pulpwood came from the Northeastern States. Since then the Lake States have supplied considerably more than the Northeastern States.

Properties.—The wood of balsam fir is creamy white to pale brown in color. Heartwood and sapwood are indistinguishable. The annual rings are distinct and are made up of a comparatively wide band of the lighter colored springwood which shades gradually into the darker, narrower summerwood. The seasoned wood is without taste or characteristic odor. Balsam fir is rated as light in weight,[16] weak in bending and compressive strength, moderately limber, soft, and low in ability to resist shock. It has a moderately small shrinkage and is not difficult to season, provided reasonable care is used in the operation. The wood is not likely to split under the action of nails but is low in nail-holding ability. Balsam fir lacks durability when subjected to conditions favorable to decay. In this respect it ranks with the least durable woods such as cottonwood, basswood, and white fir. In ability to take and hold paint it ranks with white fir and the spruces and is

[15] A cord of balsam fir pulpwood is considered to contain 300 board feet.
[16] The average weight of balsam fir in an air-dry condition (12 percent moisture) is 25 pounds per cubic foot.

placed in the third of four groups of wood, the first group containing the woods that hold paint most satisfactorily.

Balsam fir can be reduced readily by the sulfite process [17] to yield a strong pulp of good color which is fairly easy to bleach and which is suited to the manufacture of news, wrapping, and high-grade printing papers. It also reduces readily by the sulfate process to produce a very strong pulp suitable for high-grade kraft wrapping papers and fiberboard. When pulped by the mechanical or ground-wood process, the pulp is of excellent color and standard strength and is suitable for mixing with the stronger chemical pulps in the manufacture of news, cheap magazine, and cheap catalog papers and for practically all uses requiring ground wood. The power required to grind balsam fir, however, is about 20 percent more than for spruce. Balsam fir is one of the few conifers that lacks normal resin ducts. Like spruce, it is classed (for pulping purposes) as nonresinous.

Principal uses.—Balsam fir is used principally for pulpwood and lumber. The pulpwood is reduced to paper pulp largely by the sulfite process, and to a less extent by the mechanical process and by the sulfate process, and is used in the manufacture of a wide variety of papers. The sulfite pulp goes largely into high-grade printing and wrapping papers, and, in mixture with mechanical pulp, into newspaper and catalog paper. The sulfate pulp goes mostly into strong dark-colored wrapping paper and paperboard. The lumber is used principally for boxboards and crating. Some of it is made into cheese-box headings, staves for fish and sugar barrels, sardine cases, butter boxes, and the like. It makes a very desirable wood for food containers as it does not impart taste and is light in weight and color and easy to work. Lesser amounts are used for studding and sheathing, for planning-mill products such as siding and ceiling, and for sash, doors, and blinds.

Balsam fir is the source of Canada balsam—a widely known oleoresin about the consistency of honey and colorless in thin films.[18] It is used principally for the permanent mounting of microscopic specimens and as a cement for glass in optical work.

The needles of balsam fir possess a pleasing, characteristic, and lasting odor. Stripped from the branches, cleaned, and dried, they are frequently used as a stuffing for cushions.

Balsam fir is a preferred species for Christmas trees because the needles are soft to the touch and have a pleasant odor, and are retained on the tree for a comparatively long time. These advantages combined with the desired conical shape of the young trees account for

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[17] Six processes are used commercially in making paper pulp from wood. One is the mechanical or ground-wood process, in which the wood is reduced to pulp on a grindstone. The yield approaches 100 percent of the weight of the wood. Four are chemical processes—the sulfite, sulfate, soda, and neutral sulfite. They depend upon the dissolving action of chemical reagents which remove essentially all of the binding material (lignin) surrounding the cellulose fibers and leave them in a fairly pure state. The removal of the lignin is accomplished by cooking the wood chips with the proper chemical under steam pressure. The yield of pulp is about one-half the weight of the wood. In a sixth process, the semichemical, part of the lignin is removed by chemical means, and the resultant pulp, containing some lignin, is further refined by mechanical means. The yield of semichemical pulp is intermediate between the yields obtained with the mechanical process and the chemical processes.

[18] The resin is secreted in small reservoirs that appear as prominent blisters on the smooth, thin bark of young trees and branches. The resin is collected by puncturing and draining the blisters. One of the best ways of doing this is by means of a steel-pointed glass syringe fitted with a rubber bulb. The point is pushed into the blister and the contents drawn into the syringe. The average yield per tree is about one-half pound (roughly one-half pint) and comes from about 75 blisters.

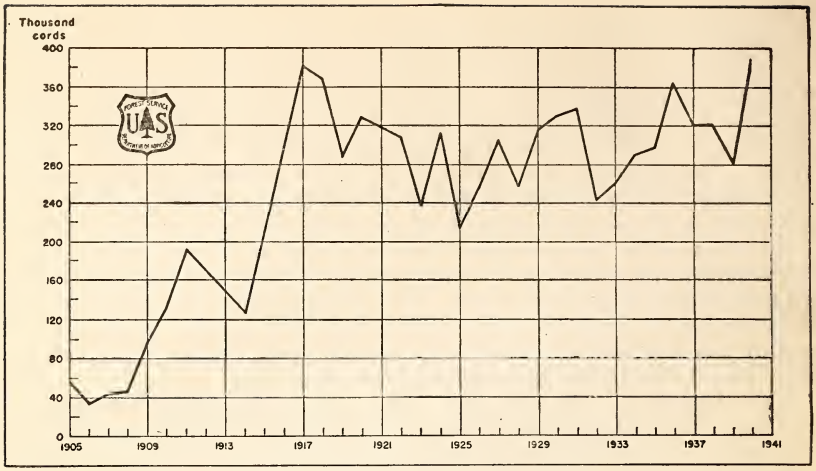

FIGURE 3.—Pulpwood consumption of balsam fir (*Abies balsamea*), 1905–40.

the many thousands that are cut both in this country and Canada.

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